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Review Article

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# Review on infectious bronchitis virus in chicken

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## Abstract

Infectious bronchitis virus (IBV), the corona virus of the chicken, is an important causative agent of infectious bronchitis in chickens and causes acute and highly contagious upper respiratory tract infections that may lead to nephritis. It affects all age groups of the chickens and occurs worldwide.IBV replicates at epithelial surfaces of different organs affecting the respiratory tract, kidneys, gonads and intestines. This virus can be detected in both respiratory and faecal materials. IBV is shed by infected chickens in respiratory discharge and faeces, spread by air born droplets, injection of contaminated feed and water, and contaminated equipment and clothing of care takers. It is one of the foremost causes of economic loss within the poultry industry, a ecting the performance of both meat-type and egg-laying chickens. Mostly, economic loss is due to decreased weight gain, reduced egg production, abnormal egg shell and quality which leads to low hatchability. Clinical signs, post mortem finding and laboratory tastes such as virus isolation and PCR are the methods for diagnosis of IBV. Chickens affected with this virus shows respiratory signs (sneezing, gasping, tracheal rales, nasal discharges, and watery eye, lethargy, kidney and oviduct lesions. A wide range of new IBV variants and subtypes emerges as a result of rapid virus genome evolution. An extremely large world chicken population (estimated about 40 billion annually) reared at a high density, with rapid virus spread, a wide use of live attenuated vaccines, and co-circulation of several virus types in one flock, allows a favourable environment for IBV recombination. Two virus strains, both field and vaccine, can recombine when they infect and replicate in one host cell. In addition to management approach, Vaccination of the flocks and individual chicken by Live and killed vaccines is the best method of prevention and control.

**Keywords:** Chicken, flocks, infectious bronchitis, poultry, virus,

## 1. Introduction

Infectious bronchitis virus (IBV) highly contagious, acute and economically important viral disease of chickens caused by corona virus infectious bronchitis virus (Boltz *et al*., 2004). It is characterized by respiratory signs, decreased egg production and poor egg quality and also replicates at many non-respiratory epithelial surface, where it may cause pathology e.g. kidney, gonads. Moreover, it is ubiquitous in most parts of the world where poultry are reared and is

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able to spread very rapidly in non-protected birds. It is shed via both the respiratory tract and the faeces and can persist in the birds and the intestinal tract for several weeks or months. Outdoors, survival of IBV for 56 days in litter has been reported. Great economic loss to the poultry industry is caused by a slowed rate of weight gain in broilers, decreased egg production, and shell abnormalities in laying hens and breeders (Cavanagh, 2005).

The virus is acquired following inhalation or direct contact with contaminated poultry, litter, equipment or other fomites. Vertical transmission of the virus within the embryo has never been reported, but virus may be present on the shell surface of hatching eggs via shedding from the oviduct or alimentary tract. Infected chickens show signs of depression, dehydration, polyuria and death, and their kidneys are swollen with severe urate deposition(Gelb *et al*., 1997). Out breaks of IB occurs frequently in spite of intensive vaccination. Infection with the field viruses was not prevented by the available vaccines, due to the serotype differences. The condition for recombination amongst IBV strains in the field is due to extremely large numbers of chickens most kept at high density in the world, ease of spread of the virus and co-circulation of serotypes including proof of co-infection with more than one serotype in a given flock (Cavanagh *et al,* 1999).

Dozens of serotypes and genotypes of IBV have been detected, and many more will surely be reported in future. The highly transmissible nature of IB and the occurrence and emergence of multiple serotype of the virus have complicated control by vaccination (Saif *et al*. 2008). To monitor the existing different IBV serotypes in a geographical region, several tests including virus isolation, virus neutralization, hem agglutination inhibition, ELISA and RT-PCR have been employed (Haqshenas *et al*.,2005; Saif *et al*., 2008). The ELISA assay is a convenient method for monitoring of both the immune status and virus infection in chicken flocks.

Several commercial ELISA kits for IBV specific antibodies detection are already available, which used inactivated virions as coating antigen (Zhang *et al.,* 2005). PCR on reverse transcribed RNA is a potent technique for the detection of IBV. In comparison with classical detection methods, PCR-based techniques are both sensitive and fast (Zwaagstra *et al.,* 1992).Samples for IBV isolation must be obtained as soon as clinical disease signs are evident. Tracheal swabs are preferred and are placed directly into cold media with antibiotics to suppress bacterial and fungal growth and preserve the viability of the virus (Swayne *et al.,*1998).Despite the use of the IBV vaccine it is common to find IBV problems in vaccinated chickens, causing a tremendous economic impact (Nouri *et al*., 2003). Consequently live and killed vaccines of various serotypes are in use, though never based on a su cient number of serotypes, for economic reasons, to control the disease as well as one would like (Bijlenga *et al.,* 2004).

## 2. Literature review

### 2.1 Etiology

Infectious bronchitis virus (IBV)was first described in the United States of America (USA) in the 1930s, as an acute highly contagious rapidly spreading viral respiratory disease (IBV), of the domestic fowl (*Gallus Gallus*; more commonly known as the chicken). A viral aetiology was established, and the agent was termed avian infectious bronchitis virus (IBV). The virus is a member of the genus *Gammacoronavirus*, subfamily *Coronavirinae*, family *Coronaviridae*, in the order Nidovirales. IBV and other avian coronaviruses of turkeys andpheasants are classified as *Gammacoronaviruses*, with mammalian coronaviruses comprising *Alpha* and *Betacoronaviruses*. Novel related coronaviruses have been discovered in wild birds and pigs and have been designated *Deltacorona viruses*, interestingly the avian *Deltacoronaviruses* have a different genomic order and show no close relationship to the *Gammacoronaviruses* (Woo *et al*., 2012).

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Coronaviruses have a nonsegmented, positive-sense,single-strandedRNAgenome.Coronaviruses are enveloped, pleomorphic, with a mean diameter of approximately 120 nm, and have large (20 nm), club-shaped surface projections, the heavily glycosylated spike glycoprotein (Boltz *et al.,* 2004). Most of IBV are inactivated after 15 minutes at $56^{0}$c and after 90minutes at $45^{0}$c.Long term storage of IBV at $-20^{0}$c should be avoided, but infectious allantoic fluid has remained viable after storage at $-30^{0}$c for many years. This virus is ether labile, but some strains survived at 20% ether at $4^{0}$c for 18 hours. It is more stable in medium at PH 6.0 and 6.5 than PH 7.0 to 8.0 in cell culture(Barnes *et al*., 2003).

## 2.2. Epidemiology

IB is virtually a global disease (Mardani *et al*.,2006) and the virus is highly infectious, presumed to spread by aerosol as well as by mechanical means. Several serotypes can co-circulate in a region. As serotypes cross-protect poorly, chickens can be productively infected several times including more than once within the short, six week life of a meat-type chicken. A wide range of new IBV variants and subtypes emerges as a result of rapid virus genome evolution (Cavanagh *et al*., 1999).

### *2.2.1. Transmission*

The disease is transmitted by the air-borne route, direct chicken to-chicken contact and indirectly through mechanical spread (contaminated poultry equipment or egg packing materials, manure used as fertilizer, farm visits, etc.). IB occurs world-wide and assumes a variety of clinical forms, the principal one being respiratory disease that develops after infection of the respiratory tract tissues following inhalation or ingestion (Woo *et al*., 2012). Infectious bronchitis virus spreads rapidly among chickens in a flock. The disease is highly contagious and has a very short incubation period. The incubation period of IBV is dose dependent and is as short as 18 hours for intra-tracheal inoculation and 36 hours for ocular application. Susceptible chickens placed with infected chickens usually developed clinical sings within 24-48 hours.

The nature of persistence of IBV infection remains undefined, although the kidney may be one of the sites of persistent infection (Dhinker and Jones, 1997).IBV vaccine virus may persist in various internal organs for up to 163 days or longer. During this period, the virus may be periodically shed in nasal excretion and feaces. Reports of extended and intermittent shedding are evidence of the potential risk of flock to flock transmission via contamination of personnel or equipment. The frequency of air born spread between flocks is unknown, although it is generally considered that IBV spreads rapidly. In view of recent discovery of IBV in species other than the chicken, it should be considered that some of other species of birds may act as vector of IBV (Jack wood *et al*., 2005**).**

### *2.2.2. Economic importance*

The extent to which this infection is an economic problem will depend on many factors, including the strain of virus, age of chicken at infection, nutrition, and the environment both within the poultry house and outside temperature (Liu and Kong, 2004). IBV replicates at epithelial surfaces of different organs affecting the respiratory tract, kidneys (some strains of the virus are nephropathogenic), gonads and intestines which leads to a great economic loss to the poultry industry by causing a slower rate of weight gain in broilers, decreased egg production, and shell abnormalities in laying hens and breeders (Cavanagh, 2005).

### *2.2.3. Morbidity and mortality*

All chickens in the flock become infected, but mortality is variable depending on virulence of the infecting serotype; age, status of immunity, either maternal or active; and stresses such as cold or secondary bacterial infections. Moderate to severe mortality has been noted with some of the respiratory and nephropathogenic strains, such as Delaware 072 and Australian T strains, respectively. Sex, breed, and nutritional are

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additional factors that contribute to the severity of kidney disease. Mortality may be as high as 25% or more in chickens greater than six weeks. Mortality in urolithiasis cases range from 0.5% to 1% per week (Vandekerchove *et al.,* 2004).

## 2.3. Pathogenesis

IBV initially infects the upper respiratory tract, where it is restricted to the ciliated and mucus-secreting cells (Dhinaker and Jones, 1997). Titres of live virus are maximal in the nose and trachea within three days and remain so for two to five days (Cavanagh, 2003). Similar virus titres occur in the lungs and air sacs. Small areas of pneumonia may be observed in the lungs, although IBV is not considered to cause pneumonia. Deciliation of the ciliated epithelia of the nose and trachea follows infection. Infection is commonly followed by secondary bacterial infections, which can be the main cause of the most debilitating disease, including mortality (Vandekerchove *et al.,* 2004). Interactions between viruses and hosts occur at two levels: viral capacity to gain access to the target cell and competition between the viruses and host cells to control the cellular protein synthesis machinery(Woo *et al*., 2012). The virus/host interactions are largely determined by the virulence of the pathogen and the host immune response (Schneider and Shenk, 2013).Some IBV strains are nephropathogenic i.e. they reproducibly cause nephritis when inoculated experimentally into SPF chickens, causing mortality. IBV infects mainly the lower nephron down to the collecting duct epithelial cells (Han *et al*., 2011).

## 2.4. Diagnosis

Diagnosis of infectious bronchitis is based on the clinical signs, history, lesions, virus isolation and detection of infectious bronchitis virus RNA. Diagnosis of this virus includes if possible, identification of the serotype or genotypes of the virus because of the availability of vaccines designed for different serotypes (De Wit, 2000).

### *2.4.1. Clinical signs*

Infection of the oviduct can lead to permanent damage in immature birds and, in hens, can lead to cessation of egg-laying with poor egg quality, or production of thin-walled and misshapen shells with loss of shell pigmentation. Infected chickens develop nephropathogenic causing acute nephritis, urolithiasis and mortality (Cavanagh and Gelb, 2008). After apparent recovery, chronic nephritis can produce death at a later time. IBV has also been reported to produce disease of the proventriculus (Yu *et al*., 2001).The characteristics respiratory sings of infectious bronchitis in chicks are gasping, coughing, sneezing, tracheal rales and nasal discharge. Wet eyes may be observed, and occasionally chick may have swollen sinuses. The chicks appear depressed and may be seen huddled under heat source. Feed consumption and weight gain are significantly reduced. In chickens greater than six weeks of age and in adult birds, the signs are similar to those in chicks, but nasal discharge does not occur as frequently, and the disease may go unnoticed unless the flock examined carefully by handling or listening to them at night when the chickens are normally quiet(Ahmed *et al*., 2007).

IBV can replicate within the epithelial surfaces of the kidneys and cause granular degeneration, vacuolation, and desquamation of the tubular epithelium, and massive infiltration of heterophils in the interstitium. IBV induced kidney lesions are typically characterized by interstitial nephritis and tubule lesions that are most prominent in the medulla (Han *et al*., 2011).The infected chickens show signs of depression, dehydration, polyuria and death, and their kidneys are swollen with severe urate deposition. Broilers chickens infected with one of the nephropathogenic viruses may appear to recover from the respiratory phase and then show signs of depressions, ruffled feather, wet droppings, increased water intake and mortality. When urolithiasis is associated with infectious bronchitis in layerflocks, there may be increased mortality, but otherwise the flock appears health(Brown *et al*., 1987).

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Inlaying flocks, declines in egg production and quality are seen in addition to respiratory signs. The severity of the production declines may vary with the period of lay and with the causative virus strain. Six to eight weeks may elapse before production returns to the pre-infection level, but in some cases, this is never attained. In addition to production declines, the number of eggs unacceptable for setting is increased; hatchability is reduced; and soft- shelled, misshapen, and rough-shelled eggs are produced(Eck, 1983).Infectious bronchitis virus infection in one day-old chicks can produce permanent damage to oviducts leading to reduced egg production and inferior quality eggs when the chickens come to lay. The severity of oviduct lesion is likely to be less in infection of older chickens, and some serotypes may fail to produce any pathologic change even in infection of one day old chicks. A presence of specific maternal antibody was also shown to protect oviduct from damage due to infectious bronchitis virus infection in early life (Chen *et al.,* 1997).

### 2.4.2. Post mortem finding

i. Gross lesion: Infected chickens have serous, catarrhal, or caseous exudates in the trachea, nasal passage, and sinuses. Air sacs may be foamy during the acute infection, become cloudy and contain yellow caseous exudate. Pneumonia may be observed around the large bronchi. Nephropathogenic infections produce swollen and pale kidney with the tubules and ureters often distended with urates (Ziegler *et al.,* 2002).Fluid yolk material may be found in the abdominal cavity of the chickens that are in production, but this is also seen with other diseases that cause a marked drop in egg production. Permanent lesion in oviduct may be a consequence of infectious bronchitis infection of one-day-old chicks. The middle third of the oviduct is most severely affected and may be non-patent and hypo glandular. In addition, lesionin reproductive tract of chickens in production been detected (Shoushtari, *et al.,* 2008).

ii. Histological lesion: The mucosa of the trachea of chickens with infectious bronchitis is oedematous. There is loss of cilia, rounding and sloughing of epithelial cells, and manor infiltration of heterophils and lymphocytes within 18 hours of infection. If sac involvement occurs, there is oedema, epithelial cell desquamation, and some fibrinous exudateswithin 24 hours. Increased heterophils can be observed later with lymphoid nodules, fibroblast proliferation, and regeneration by cuboidal epithelial cells. The lesion of infectious bronchitis is principally those of an interstitial nephritis. The virus causes glandular degeneration; vacculation and desquamation of the tubular epithelium (Riddell, 1987).

### 2.4.3. Laboratory tests

i, Virus isolations: The trachea is a primary target for IBV and is, therefore, a preferred sampling site, especially with in the first week of infection. The sample could be either tracheal swabor tracheal tissues collected at post-mortems examination.Cloacalswabs orcecal tonsils collected during post mortem have more particular values in cases in which more than one week may have elapsed since the start of infection. Consequently, the virus is generally cleared from the trachea sooner than from the intestinal tissues. Additionally evidence exists that IBV can persist, especially in non-respiratory tissues like kidney.Samples from the lung, kidney, and oviduct should also be considered depend on the clinical history of the disease.(Lucio and Fabricant, 1990).

Samples of virus isolation commonly are inoculated into embryonated chicken eggs or tracheal organs cultures preferably from a specific-pathogen free. Fluid should be harvested after 48-72 hours from the culture system. The virus presence must be confirmed by serological methods like virus neutralization HI, ELISA, immunochemistry, nucleic acid analysis, or by electron microscopy (De Wit, 2000, 64).

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ii, Antibody Based Method: Detection of IBV directly using post-mortem material may be attempted by a number of methods. Sections or scrapping of the tracheal mucosa and other tissues taken from chickens at post-mortem can be examined by immune fluorescence (Hangberg *et al*., 1999). The result is not easy to interpret because of non-specific reaction. IBV in allantoic fluid or after growth in tracheal organ cultures may detected and identified as to serotype, using monoclonal antibodies in indirect or antigen capture (ELISA) (Lucio and Fabricant, 1990).

iii, Nucleic Acid Based Method: Diagnosis of infectious bronchitis (IB) in the laboratory is commonly based on virus isolation in embryonated eggs, followed by immunological identification of the isolates. This procedure is time consuming and requires the use of specific polyclonal or monoclonal antibodies. Moreover, some isolates could be mixtures of different types of IBV that can confuse the interpretation of stereotyping results. Reverse transcription PCR has been described previously using IBV, RNA extracted from allantoic fluid, and tracheal swabs. These techniques had been shown to be very efficient for the detection of IBV and for the identification of IBV types (Cavanagh *et al.,* 1999).

RT-PCR genotyping methods have largely replaced HI and VN serotyping for determining the identity of field strain. RT-PCR produce cycle sequencing of the hyper variable aminoterminal region of s1 may be used diagnostically to identify previously unrecognized field isolates and variants (Fulton *et al*., 1993).

## 2.5. Differential diagnosis

Some acute respiratory disease is similar with infectious bronchitis virus. It should be differentiated from New castle disease, infectious laryngotrachitis, infectious coryza, avian encephalomyelitis, mycoplasmosis, colibacilosis, low pathogenic avian influenza and other cause of egg peritonitis. New castle disease is differentiated from infectious bronchitis by its high mortality, nervous sings with virulent strains of new castle disease and in laying flock; drop in production may be greater than with the infectious bronchitis. For Newcastle disease virus, it was reported that the more virulent strain persisted longer in the chickens and, therefore, was able to increase the magnitude and duration of cell-mediated immunity (Saif *et al.,*2008).

Infectious laryngotrachitis show some clinical sing that are important for differentiation from infectious bronchitis infection, haemorrhagic exudate and tends to spread more slowly in flock, but respiratory sings may be more severe than infectious bronchitis. Egg drop syndrome, production decline and shell quality problems in flock are similar except that internal egg quality is not affected (Eck, 1983). Infectious coryza may be differentiated from infectious bronchitis by rare occurrence of facial swelling and in infectious bronchitis, nasal discharge occurs only in young chicks. Additionally, avian encephalomyelitis should be considered and with infectious bronchitis, abnormal eggs such as deformed egg are laid during recovery and the infection is long lasting. Avian encephalomyelitis differ from infectious bronchitis disease in that, hatching rate is lowered in the fertile eggs and after hatching the chickens show nervous signs and they will die (Koichi *et al.,*2000).

## 2.6. Control and prevention

In areas where there are many poultry farms, it is virtually impossible to keep chickens free of IBV. Biosecurity is likely to be in su cient, as the virus is spread readily. Consequently vaccination is commonly practised. Whilst the humoral response to IB vaccination has been measured for many years, very little is known about the cellular immunity induced by IB vaccines or field strains (Vandekerchove *et al.,* 2004).

### *2.6.1. Treatment*

No specific treatment exists for infectious bronchitis. But, different management approaches should be applied. Provision of additional heat to eliminate cold stress, elimination of overcrowding, and attempts to maintain feed

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consumption to prevent weight loss are flock management factors that may help to reduce losses from infectious bronchitis(Saif*etal*.,2008). Treatment with appropriate antibacterial may be indicated to aid in reducing the loss from air saculitis resulting from infection by secondary bacterial pathogens.

Electrolyte replacers, supplied in drinking water, are recommended to compensate for acute loss of sodium and potassium and to thereby reduce loss from nephritis. The recommended concentration for treatment is 72Meq (mili equivalent) of sodium and/or potassium, with at least one-third in citrate or bicarbonate salt form. All infectivity of IBV is destroyed by 50% chloroform at room temperature after 10minutes and 0.1% sodium deoxychlorate at $4^0$c for 18hours. Treatment with final concentration of 0.05 or 0.1%beta-propiolactone (BPL) 0r 0.1% formalin eliminate IBV infectivity (Cavanagh, 2003).

### *2.6.3 Vaccination*

i, Live vaccines: Vaccination to control IB has been practiced for over a half a century (Bijlenga *et al*., 2004).Live vaccines are usually applied to meat-type chickens at one day of age, in the hatchery. In experimental situations, this can result in sterile immunity when challenged by virulent homologous virus within three weeks of vaccination. Sometimes, even in closely controlled experimental situations, 10% of vaccinated chicks do not respond with a protective immune response against challenge with the homologous strain (Nix *et al.,* 2000).

In this context there is another aspect of IB vaccination to be kept in mind; protection is short-lived, the start of the decline being apparent nine weeks after vaccination (Darbyshire and Peters, 1984). Consequently commercial egg layers, which are kept for a year or more, are vaccinated several times with live vaccine, perhaps with more than one serotype. Even broilers, which are processed at only six or so weeks of age, may be revaccinated if IB is very problematic in an area. Revaccination may be with a di erent serotype, as this approach sometimes gives protection against a broader range of serotypes (Cook *et al.,* 1999). The e cacy of vaccination with live vaccine varies amongst inbreed lines of chickens i.e. genetic deference between individuals a ects the e cacy of the immune response (Penseart and Lambrechts, 1994).

Vaccines have not been developed commercially with nephropathogenic IBV strains in mind. However, this has been studied experimentally. Vaccination, by coarse spray, with the homologous attenuated strain completely protected against mortality upon challenge four weeks later with the wild-type nephropathogenic virus. Challenge virus in the kidney was assessed by immune fluorescence. By this criterion the number of chicks with detectable IBV in the kidney was reduced by84% by vaccination with the homologous vaccine, and not at all by the hetrologous vaccines. (Pei *et al*., 2001).

Broilers are most commonly vaccinated with live infectious bronchitis vaccine in the hatchery (i. e. at one day of age). A second vaccine of the same or different serotype may be given at ten to eighteen days of age. Broilers, breeders and commercial layers are likely to be fist inoculated with live infectious bronchitis vaccine at about two to three weeks of age. Schedules of subsequent immunization at seven to twelve or sixteen to eighteen weeks of age and at point of lay vary with flock management and needs for control of infectious bronchitis, as well other flock disease (Casais *et al*.,2005).

ii, Inactivated virus vaccines: Inactivated oil-emulsion IBV vaccines were developed during the 1960s and 1970s. The objective was to make a vaccine that would give long-lasting immunity to the hen bird, to protect against drops in egg production. Single applications of inactivated virus induced little or no protection against egg loss and no protection against loss of biliary activity in the trachea (Martins *et al*., 1991). It has been shown that experimentally the vaccine strain H-120 can spread rapidly from vaccinated to non-vaccinated broilers, protecting them against the challenge with virulent M-41 strains (Matthijs, *et al*.,2008).

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iii, Vector vaccines: S1 has also been expressed in birds using fowl pox virus (Wang *et al.,* 1994) and fowl adenovirus vectors. Remarkably, expression of S1 in birds using a non-pathogenic fowl adenovirus vector induced protection in 90% and 100% of chickens in two experiments. This was the case after only a single application of the vector. Success may have been related to the fact that the vector replicated well in the respiratory tract of the chickens (Jonson *et al.,* 2003).

## 3. Conclusion

IBV is highly contagious viral disease of chickens which occurs in all countries throughout the world. It affects all age groups of chickens and reduces the productivity as well as performance of the flocks. These disease leads to great economic loss in poultry industry due to reduction in both egg quality and quantity in layers, and loss of body weight in meat type. It spreads rapidly from flock to flock or between individual chicken by aerosols from infected chickens, contaminated feeds and water. However, diagnosis of IBV depends on clinical signs (coughing, nasal discharges, ruffled feather, sneezing, respiratory rales, dipratione tc), post mortem finding, different laboratory tests. Management approach (biosecurity, traffic control, quarantine etc), and vaccination is the best methods for control and prevention of IBV.

According to the above conclusion, the following recommendations are forwarded:

- Good management approaches should be takes place in order to avoid the great economic loss from poultry industry.
- It is better to understand the methods of diagnosis, prevention and control to prevent great economic loss due to IBV.
- Secondary bacterial complication must be treated before it reaches maximum infection.
- Vaccination of all flocks and individual chicken at necessary intervals throughout the year is needed.
- Future vaccinations will only be economically feasible to develop new vaccine against a tiny number of new types of infectious bronchitis virus. Therefore, control of infectious bronchitis will continue to involve “juggling” with a very small selection of vaccines, plus good management.

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